

Appln No. 10/542,438
Reply to Office Action of June 11, 2007

REMARKS/ARGUMENTS

Claims 1 to 29 are currently pending in this application. Claims 1, 3, 5, 8, 10, 12, 13 and 18 have been amended. No new matter has been introduced by the amendments set forth in this response.

Rejections Under 35 U.S.C. §112

The Examiner rejected claims 10, 13 and 14 as being indefinite under 35 U.S.C. § 112, second paragraph. Specifically, the Examiner rejected claim 10 for failing to adequately set forth the steps to be carried out. Although Applicants have amended claim 10 to more particularly point out that homogenizing the bubbles may be carried out by "regulating" the size dependent velocity of the bubbles, thereby obviating this rejection.

The Examiner also rejected claim 13 as failing to adequately set forth the scope of the claim. Applicants have amended the language of the claim to more clearly recite that the formation of the foams may be made *in situ* in a mold or cast, thereby obviating this rejection.

Finally, the Examiner also rejected claim 14 as failing to set forth the "size distribution" claimed. Applicants do not understand the Examiner's confusion. The claim sets forth clearly that the bubbles in the invention will have a size distribution of "around 10 μm ". Applicants believe this is both definite and clearly set forth. Should the rejection be maintained Applicants request the Examiner more clearly explain what further specificity would be required.

Rejections Under 35 U.S.C. §103

The Examiner rejected claims 1 to 29 under 35 U.S.C. §103(a), as being unpatentable in view of Patten (USPN 4,099,961) and Apfel (USPN 5,384,203). Applicants respectfully traverse this rejection.

The current claims are directed to a method of forming an amorphous foam in accordance with the following steps:

- Heating the alloy to its liquidus temperature and introducing bubbles into the alloy where the bubbles have a specific internal bubble pressure;
- Cooling the precursor to at least the alloy's glass transition temperature of the alloy; and
- Expanding the bubbles in the precursor while the precursor is at a temperature between the nose of the crystallization curve and above the glass transition temperature of the alloy by providing a pressure gradient to the precursor where the pressure during the expansion is lower than the internal bubble pressure of the introduced gas bubbles formed during the precursor forming step.

The process described in the Patten patent differs in a number of significant ways. First, in Patten the bubbles are introduced into the alloy by sputtering the material under an inert gas environment. (See, e.g., Patten, col. 1, lines 58 to 62 and col. 2, line 52 to col. 3, line 58.) Nowhere does Patten require or even suggest that the alloy be heated to its liquidus temperature before introducing the bubbles as required by the claims of the current invention.

Second, the current process requires that the alloy be cooled to between the nose of the crystallization curve but above the glass transition temperature of the alloy. Nowhere does Patten teach, describe or even suggest such a step. In fact, nowhere does Patten ever even discuss the importance of the nose of the crystallization curve or glass transition temperature. Moreover, nowhere does Patten ever even suggest cooling the metal before the final quenching step, and even when an ultimate cooling process is described Patten clearly references it as optional stating:

While it is not necessary to cool the body rapidly to a temperature below the melting temperature of the metal in the body, it is convenience [sic] to do so, since once again it is the length of time

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above the melting temperature which affects the cell structure and the total void fraction of the foamed metal. (Patten, col. 4, lines 47 to 53.)

Finally, the current invention teaches that to expand the bubbles within the precursor to form the final foam material, the pressure of the precursor must be reduced to a pressure lower than that used during the step where the bubbles were formed, such that the internal pressure of the bubbles is higher than the pressure of the precursor itself. Nowhere does Patten ever describe, teach or even suggest that the pressure of the environment around the precursor be adjusted, much less that the pressure of the material during the introduction phase must be kept higher than the pressure during the expansion phase.

In short, although Patten does describe a method of forming close cell foam materials, the process for doing so is entirely different. Moreover, the Apfel patent while certainly describing methods for forming foams of amorphous metals does not correct the deficiencies of the Patten patent. Specifically, the Apfel patent describes a patent in which the foam is formed by the injection of a liquid followed by a rapid decompression. Such a method is not at all comparable to the current process. For example, the Apfel process nowhere describes or even suggests cooling the alloy to a temperature range between the nose of the crystallization curve and the glass transition temperature of the alloy as required by the claims of the instant application. Indeed, such detailed processing parameters are not needed in Apfel because the process and the foam created by the process are entirely uncontrollable, as discussed in the background of the instant application.

In light of the deficiencies in the prior art, Applicants submit that one of ordinary skill in the art, having read the Patten and Apfel patents in combination, would have had no motivation to create a process for creating metallic amorphous foams in accordance with the current invention.

Rejection Under 35 U.S.C. §102e/f/g

The Examiner also rejected claims under 35 U.S.C. §102e(e)/(f)/(g) as being anticipated by the patent to Kang et al. (USPN 7,073,560. Applicants respectfully traverse this rejection.

Although Kang et al. do describe some of the same processing parameters, the current invention provides a far more sophisticated understanding of how to controllably produce homogenous foam structures. For example, the current invention, in accordance with amended claim 1, includes the limitation that before processing the alloy be cooled to “below the nose of the crystallization curve of the alloy and above glass transition temperature of the alloy.” Nowhere do Kang et al. ever teach or even suggest the importance of this temperature region. Indeed, nowhere do Kang et al. ever discuss the nose of the crystallization curve for such amorphous alloy foams at all. This is a critical feature of the invention. For example, Applicants disclose:

The under-cooled region is accessed by cooling from the stable liquid (circles) and by heating the solid amorphous state (squares).

At low temperatures, below 750 K, no noticeable difference between the heated and cooled samples in the under-cooled liquid can be observed provided that such heating and cooling is achieved sufficiently fast to avoid any significant crystallization.

Furthermore, a relatively large range of viscosity values can be observed in the under-cooled liquid regime of bulk-solidifying amorphous alloys. For example, FIG. 2 shows the viscosity as a function of temperature for Zr₄₁Ti₁₄Cu₁₂Ni₁₀Be₂₃ (Vit-1) as shown, the viscosity of this bulk-solidifying amorphous alloy changes by ~13 orders of magnitude in the undercooled liquid regime.

The applicants discovered that the sluggish crystallization kinetics (see FIG. 1) can be beneficially exploited to develop novel processing methods for bulk-solidifying amorphous alloy foam structures. Furthermore, the applicants discovered that utilizing these novel processing methods and by accessing a large regime of viscosity values, between ~1 Pas and ~ 10^{13} Pas, highly homogeneous and controllable amorphous metallic foam structures can be obtained. Applicants further discovered that these novel methods of processing amorphous alloys into metallic foam structures can substantially forego or relax the dimensional limitations arising from the critical cooling rate to form an amorphous phase. (Specification, paragraphs 46 & 47.)

Nowhere do Kang et al. ever even discuss these concepts in connection with processing metallic foams, much less how to regulate the process parameters of foam creation by manipulating temperature and viscosity in this manner. In short, Kang et al. simply do not teach or even suggest one of the processing steps of the current invention. Accordingly, the current invention simply cannot be considered anticipated by the disclosure of the Kang et al. patent.

Double-Patenting Rejection

Finally, the Examiner also rejected claims 1 to 29 on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 to 41 of the Kang et al. patent. Applicants again respectfully traverse this rejection.

Specifically, in addition to the above comments, which are equally valid here, Applicants would point out that the current invention is directed to a process for forming amorphous alloy foams. All of the claims of the Kang et al. patent are directed to metallic foams not to methods of forming metallic foams as claimed in the current invention. Indeed, nowhere do any of the claims of the Kang et al. patent include any

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reference to process parameters, much less to the specific process parameters claimed in the current application. Accordingly, Applicants do not understand how the claims of the instant application can be considered "patentably indistinct" over the claims of the Kang et al. patent.

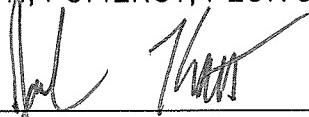
Conclusion

In view of the foregoing amendment and response, it is believed that the application is in condition for further examination. If any questions remain regarding the allowability of the application, Applicant would appreciate if the Examiner would advise the undersigned by telephone.

Respectfully submitted,

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